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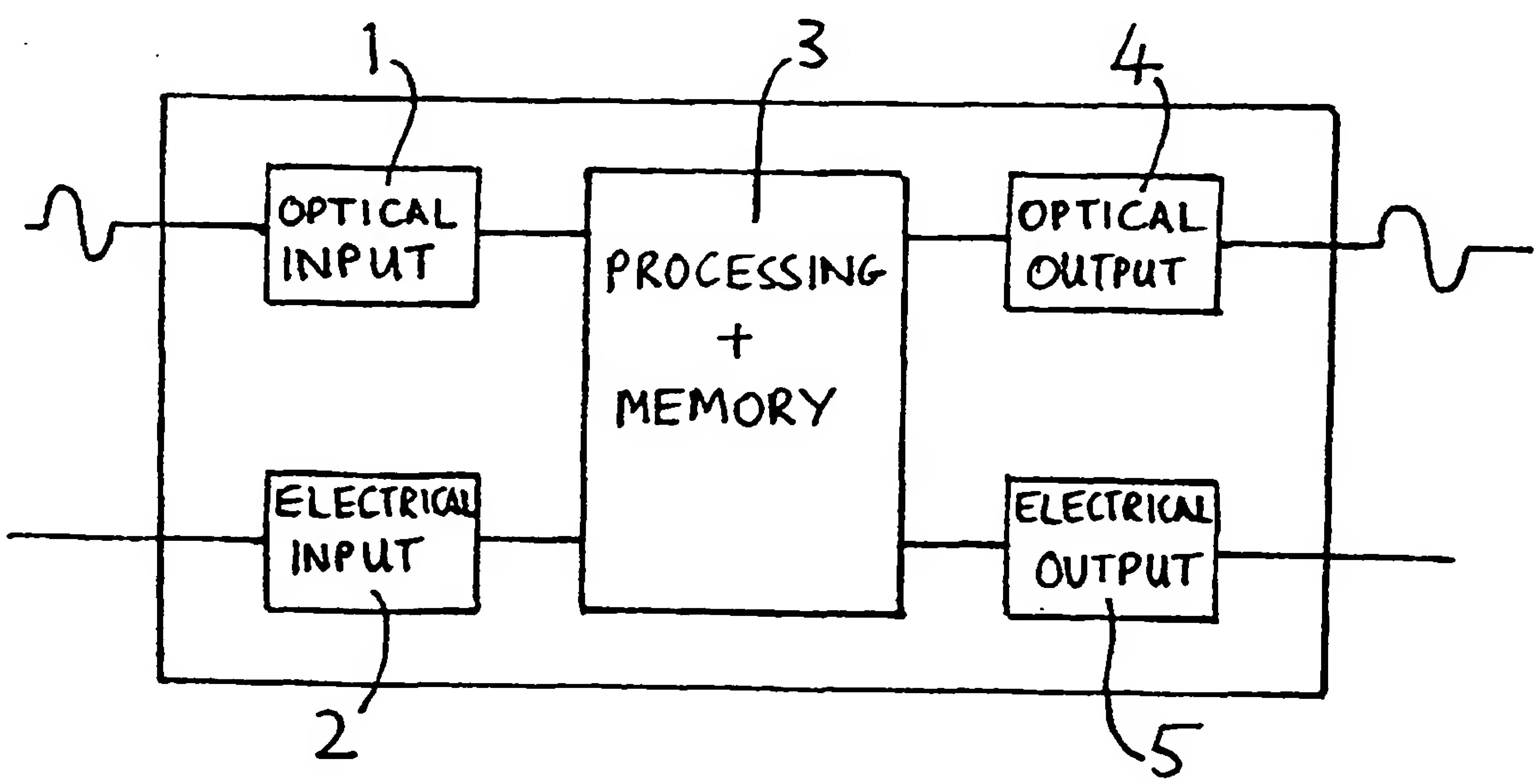

(57) Abstract: An optoelectronic device includes a substrate (6, 7) comprising semiconducting material and an array of smart pixels arranged on or in the substrate, each smart pixel comprising at least one layer (12) of organic light emitting material, and a light permeable electrode (13) in contact with the organic layer on a side thereof remote from the substrate. The smart pixels may be capable of one or more of a range of functions, including image sensing, processing, communication and display.

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AN OPTOELECTRONIC DEVICE

BACKGROUND TO THE INVENTION

The present invention relates to an optoelectronic device.

Organic light emitting diodes (OLEDs) comprise certain organic materials which are known to emit light under electrical stimulation. The materials can be either small molecules or polymer materials (in polymer light emitting diodes, PLEDs). These materials require different processes for practical manufacture into devices. Small molecule materials are deposited onto a substrate by vapour deposition whilst polymers are cast onto a substrate from a solution by spin-coating, printing, doctor blading or a reel-to-reel process. In a typical polymer LED, a polymer layer is deposited, by spin coating, onto indium tin oxide (ITO) coated glass. This is followed by heat treatment to drive off residual solvent and a reflective metal electrode is then evaporated onto the top surface of the polymer layer. The ITO, which is transparent, forms the other electrode and the polymer emits light through the ITO coated glass when a voltage is applied between the electrodes. Current and voltage control of the light emission is known.

Both types of materials and processes have been used to fabricate arrays on a number of different transparent and non-transparent surfaces. Methods known in the art for creating full colour displays include ink-jet printing of polymer solutions and vapour deposition of small molecule materials. Other known methods include the use of monochrome displays fitted with individual absorptive filters or colour changing media filters. Whilst both materials appear compatible with photo-resist technology, in practice the processing has reduced the efficiency and lifetime of the devices to unacceptable levels. High-resolution colour and monochrome displays have been demonstrated for small molecules by depositing them into microcavities. In EP-0,774,787, a full colour OLED array is fabricated on a CMOS substrate by this method. The drivers for the diode array are formed in the substrate.

Various types of liquid crystal display have been fabricated on crystalline silicon (LCOS) and other silicon materials such as polysilicon on glass. The silicon material

provides the active matrix drive circuitry as well as the substrate. Similarly, a vacuum fluorescent display has been fabricated on crystalline silicon.

The manufacture of arrays of OLEDs on non-transparent substrates such as CMOS or bi-CMOS is hindered by the need to fabricate an (at least semi-) transparent electrode on top of the organic layers to allow light emission and viewing. Deposition of indium tin oxide directly onto the organic layers can cause unacceptable deterioration in the device performance. Another consideration is the need to carefully select the choice of metal electrode material directly in contact with the substrate so that it is fully compatible with microelectronic manufacturing equipment.

An electronic display is, in effect, a pixelated optoelectronic device in which electronic information is fed on to the display and converted to optical information on a pixel-by-pixel basis. A smart pixel array (SPA) is an array of optoelectronic pixels (also called cells or units) in which each pixel has the capability to communicate with other pixels in the same array or another array by electrical and/or optical means. The configuration of the communication (which cells communicated with which others by which means and in which direction) is usually dynamically programmable by means of optical or electrical signals fed to the SPA. Often communication within an array of pixels on the same substrate is done by electronic means while communication between pixels in separate arrays or on separate or remote substrates is done by optical means.

SPAs have been implemented in the past in technologies such as, for example, liquid crystal over crystalline silicon, monolithic III/V semiconductor, and III/V semiconductor bonded to CMOS silicon by flip-chip technology.

SPAs have been used in fields as diverse as, for example, image processing, telecommunications switching and optoelectronic neural networks.

The optical communication between SPAs is often carried out using light or electromagnetic radiation of wavelengths other rather than visible. For example, SPAs used in telecommunications systems often use infra-red wavelengths.

SUMMARY OF THE INVENTION

According to the present invention there is provided an optoelectronic device including a substrate comprising semiconducting material and an array of smart pixels arranged on or in the substrate, each smart pixel comprising at least one layer of organic light emitting material, and an (at least semi-) transparent electrode in contact with the organic layer on a side thereof remote from the substrate.

Preferably, and in particular where the device forms a display, the electrode comprises an electrically conducting polymer, and preferably, the surface of the substrate is polished or smoothed to produce a flat surface.

The substrate may consist of amorphous, polycrystalline or monocrystalline silicon. Alternatively, the substrate may comprise a layer of amorphous, polycrystalline or monocrystalline silicon overlying a layer of glass or sapphire. Preferably, the polishing or smoothing of the substrate is effected prior to the deposition of the electrode, or organic, materials of each OLED smart pixel. The smart pixels of the array may be different, similar or identical, or the array may comprise any two or all three of different, similar and identical smart pixels. Pixels in the array which are physically similar or identical may be programmed once and for all or dynamically to perform the same or different functions.

The smart pixels are preferably of the same size and may be arranged as squares or rectangles on a Cartesian grid. Other grids, such as hexagonal pixels on a hexagonal grid or ring, and wedge shaped pixels on a polar or radial grid, are also feasible as embodiments of the invention.

Each smart pixel of the array is capable of carrying out one, some or all of the following tasks:

- Process information electronically within the pixel

- Store information within the pixel

- Transmit electrical signals to one or more other pixels in the same array by means of conducting layers which form part of an active circuit or to one or more pixels in one or more other arrays by a means conventionally used in electric or optical chip to chip interconnect (such as copper tracks on a PCB, wires in a ribbon cable or optical fibres)

- Receive electrical signals from one or more other pixels in the same array by means of conducting layers which form part of an active circuit or to one or more pixels in one or more other arrays by a means conventionally used in electric or optical chip to chip interconnect (such as copper tracks on a PCB, wires in a ribbon cable or optical fibres)

- Transmit optical signals to one or more other pixels in the same array or another array by means of light waves propagating in free space or through an optical system

- In the case of organic light emitters, such as LEDs, micro-cavity LEDs, laser diodes or organic modulators utilising absorption shifting mechanisms, convert electrical signals into optical signals, for off-chip communication

- Receive optical signals from one or more other pixels in the same array or another array by means of light waves propagating in free space or through an optical system

The above processes may be carried out singly, or some or all together at the same time, or in sequence, one after the other or in any other combination.

Optical signals received by a pixel may be arranged to be converted into electrical signals by conversion means, for example, one of the following:

- One or more PN junction diodes or PIN diodes or phototransistors or photoconductors or one or more other photosensitive elements or some combination of these, within the active substrate, (each) electrically connected to suitable amplification circuits within the active circuit

- One or more organic photodiodes or phototransistors or other photosensitive elements formed in a layer above the active circuit and (each) electrically connected to the input of a suitable amplification circuit within the active circuit

- Some combination of the above semiconductor photosensitive and organic photosensitive structures each of which is electrically connected to the input of a suitable amplification circuit within the active circuit

Electrical signals within the pixel are preferably arranged to be converted into optical signals by means of one or more driver circuits, within the active circuit, (each of) whose output is connected to the underside of an arrangement of one or more organic light emitting diodes in series or parallel or both, formed in a layer above the active circuit. The top side of the organic light emitting diode or diodes is preferably connected to an electrode which is common to some or all of the organic light emitting diodes in the smart pixel array. This common electrode is preferably of metal and in contact with the substrate. Depending on the relative work functions of the metal and transparent electrodes, either may serve as the anode with the other constituting the cathode.

In one embodiment, the smart pixels are configured to form an optoelectronic communication link on- and off-chip, for microsystem integration, computer interconnect, datacom or telecom applications. For example, the smart pixels can enable chip-to-chip communication to relieve data bottlenecks, enable optical clock distribution to synchronise systems or allow direct chip access to optical disks or optical memories where conversion to/from electrical signals is performed at the smart pixel.

The pixel configuration may be capable of providing data buffering and multiplexing and demultiplexing functions and handling data protocols. Organic photodiodes or phototransistors may convert optical signals into electrical signals for on-chip communication. Parallel communication links can be provided by spatial, temporal or wavelength multiplexing. Wavelength multiplexing can be provided by different pixels preferentially emitting and/or absorbing different colours of light. For example, microcavity structures, possibly in conjunction with doping of rare-earth metals, can be employed to give narrow-band sources at selected wavelengths. The doping,

microstructuring, or voltage applied can be selected to varying the wavelength from pixel to pixel as required. Also, organic emitting devices, in conjunction with narrow band photoluminescent, colour conversion structures can be employed.

The optoelectronic communication links can be point-to-point, multi-cast or broadcast. The links can be static (fixed) or dynamic (reconfigurable). Optical fibres, optical waveguides or free-space microoptics/optics can be used to transfer the light from source to destination. The organic optoelectronic devices can be micro-structured to ease optical coupling. Passive or active optical waveguide structures in organic or inorganic materials can be integrated with the smart pixels on the same substrate.

In one embodiment, the smart pixels are configured as an image sensor and/or display. Broadband or narrowband light in the range of wavelengths from the ultraviolet to infrared, incident upon the smart pixels can be converted to a digital representation and stored at the pixels. Localised image-processing operations, such as image enhancement, equalisation or data encryption can be performed. The data can then be output optically in the form of a displayed image, or transported elsewhere as optical or electrical communication signals. For example, infra red images can be converted for display in visible colours.

In one embodiment, the smart pixels are configured as an image sensor and/or printer. The optical signals can be used to transfer images from storage on the pixel array to a light sensitive film.

The organic light emitting material is preferably a polymer but may alternatively be a monomer or a transition metal chelate. Apart from the light emitting material, organic layers in the pixel elements may include an electron transport material layer, a hole transport material layer, a protective cap material layer and a conducting polymer material layer.

As well as a conducting polymer, the (at least semi-) transparent electrode may comprise further layers, e.g. of indium tin oxide (ITO) or other transparent or semi-transparent metal oxides or low or high work function metals, or conducting epoxy resin,

deposited onto the organic layer furthest from the substrate. Alternatively, a glass or plastic sheet, coated with ITO, conducting polymer, or at least one of the layers that constitute the (at least semi-) transparent electrode, may be bonded to said furthest layer or another layer of this electrode, to complete the electrode and serve as a barrier to the ingress of oxygen and water. The surface of the device may be completed by encapsulation with a further layer of polymer or glass.

The preferred conducting polymer is poly(ethlyendioxythiophene), sold by Bayer AG under the trade mark PEDOT. Other molecularly altered poly(thiophenes) are also conducting and could be used, as could the emaraldine salt form of polyaniline. To improve the adherence of PEDOT to certain smooth substrates a polymer blend with a non-conducting polymer, preferably poly (vinyl alcohol) (PVA), can be made. For example, a 9 wt% solution of PVA with PEDOT in a 10(PVA):6 volume ratio can be used. A wide range of molecular weights of PVA can be used without much difference in the resultant film or its conductivity.

In still another embodiment, a metal electrode may consist of a plurality of metal layers, for example a higher work function metal such as aluminium deposited on the substrate and a lower work function metal such as calcium deposited on the higher work function metal. In another example, a further layer of conducting polymer lies on top of a stable metal such as aluminium. Preferably, the electrode also acts as a mirror behind each pixel and is either deposited on, or sunk into, the planarised surface of the substrate. However, there may alternatively be a light absorbing black layer or reflective structure between each pixel.

High work function metals that could be used include tungsten, nickel, cobalt, platinum, palladium and their alloys, and possibly niobium, selenium, gold, chromium, tantalum, hafnium, technetium and their alloys.

The substrate may also provide data drivers, data converters and scan drivers for processing information to address the array of pixels so as to create images.

In a method of making the optoelectronic device according to the invention, the organic devices can be integrated directly onto the semiconductor circuit substrate, formed by vacuum deposition, printing, stencilling or spin coating methods, or formed separately and hybridised, using flip-chip or wafer bonding methods. These processes could be low-temperature (<100°C) and allow full hermetic encapsulation, to maximise device life-time and performance.

In still another embodiment of the method, selective regions of a bottom conducting polymer layer are made non-conducting by exposure to a suitable aqueous solution allowing formation of arrays of conducting pixel pads which serve as the bottom contacts of the pixel electrodes.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the present invention may be more readily understood, reference will now be made, by way of example only, to the accompanying drawings, in which:-

Figure 1 is a schematic diagram of a smart pixel which can be implemented using the invention;

Figure 2 is a schematic cross section of a smart pixel according to an embodiment of the invention;

Figure 3 is a schematic cross section of a single pixel of a planarised substrate according to an embodiment of the invention (not showing the polymer LED);

Figure 4 is a schematic cross section of an alternative substrate, showing the deposited polymer LED, and

Figure 5 is a schematic, fragmentary side view of an array of polymer LEDs.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a smart pixel which is capable of receiving optical signals at an optical Rx 1 and electrical signals at an electrical Rx 2. The received signals are

processed in a processor 3 where data can optionally be stored. Optical signals are transmitted from an optical Rx 4 and electrical signals are transmitted from an electrical Tx 5.

Each smart pixel in the array of the invention may be as exemplified in Figure 2. The pixel comprises, from bottom to top, the following elements: a passive substrate 6, an active substrate 7, active electronic devices 8, circuit electrical interconnections 9, pad connections 10 to organic conducting and light emitting/detecting layers, two unspecified series 11, 12 of conducting, organic conducting, hole transport, electron transport and organic light emitting or detecting layers, and a transparent conducting layer 13 forming a transparent electrode. One of the series 11 includes at least one light detecting layer whilst the other series 12 includes at least one light emitting layer. A planarising dielectric 14 may cover the active substrate 7.

Once the active matrix circuitry has been fabricated in the semiconductor substrate, for example using CMOS technology, the surface of the substrate can be planarised. This planarisation either takes place as part of the manufacturing process of the integrated circuit or as a subsequent customising step.

As shown in Figure 3, the planarisation is effected by depositing the dielectric 14, for example a polymeric material, on the surface of the active substrate 7. A conducting polymer that can be patterned to create areas of insulation can be used instead for this purpose. A metal mirror/electrode 34, which may be of aluminium, for connecting one of the series of layers 11 to the appropriate point in the circuit, is then deposited, the connection to the circuit being established by a metallic conducting via 36. Metallised portions of the CMOS circuit are designated 38.

Figure 4 shows an alternative arrangement in which the electrode/mirror 34 is sunk into the dielectric surface, i.e. full planarisation is achieved.

Figure 4 also shows one way in which the device construction can be completed. The series of layers 11 is deposited and the display is sealed by coating with a glass plate

42 coated on its inner surface with a transparent conducting layer 43 which comprises the conducting polymer and, optionally, ITO.

Figure 5 shows an alternative device construction including a particular example of the series of deposited layers. For simplicity, Figure 5 shows ordinary pixels instead of smart pixels, but the example is equally applicable to forming smart pixels according to the invention. On the substrate 32 there are deposited, in turn, the planarised aluminium electrode/mirror 34, optionally an electron or hole transport layer 44, a light emitting polymer 46, and a transparent electrode 48. The transparent electrode may for example consist of a thin layer of high work function metal 49, of a thickness to be adequately transparent, a layer of conducting polymer 50 and a layer of ITO 51. An encapsulation layer/barrier 52 which seals all of the LEDs of the array, including their sides, completes this example of the display construction, three pixels of which are shown in Figure 5.

In manufacturing the display shown in Figure 5, the flat metal mirrors 34 are applied to the surface of the substrate 32 (preferably a CMOS or bi-CMOS backplane) so as to cover most of the area of each pixel with minimal gaps between the mirrors. Chemical Mechanical Polishing may be used to enhance the global and local planarisation.

The layers of polymer and related materials can be deposited by an automated technique using equipment currently used for applying photo-resists used for the patterning of integrated circuit layers. This gives precise control and a uniform thickness for each layer. Alternatively, the polymer layers could be ink-jet printed. Rare earth chelates can be vacuum deposited.

The encapsulation layer 52 is applied after making the connections to the transparent electrode in each pixel. Encapsulation, and possibly the assembly of the pixel, are carried out in clean, dry conditions under a partial vacuum, or a suitable inert or controlled atmosphere.

The display of the invention is robust, the organic LEDs being well protected, but has simplified manufacture and encapsulation. The power generated as heat should be

manageable but could be decreased by reducing the current or voltage used to drive each element. If current routing problems arise, multiple power supply bond pads can be used on the silicon chip.

INDUSTRIAL APPLICABILITY

Devices according to the present invention can be used to implement any of the following:

- Optoelectronic displays

- Optoelectronic computing systems, including neural networks and digital parallel networks

- Optoelectronic interfaces between the electrical/ electronic domain and the optical domain in datacoms/telecoms, optical backplanes and chip-to-chip (inter and intra) interconnect

- Optoelectronic cross-connects, switches, buffers, add/drop multiplexers, for datacoms/telecoms, optical backplanes and computing interconnects

- Smart sensors and/or printers for digital photography, photolithography and material processing

- Smart sensors and/or displays, with integrated functions such as pattern recognition, compressed data, image enhancement, smart resolution, smart gain, smart colour conversion.

All forms of the verb "to comprise" in this specification mean "to consist of or include".

CLAIMS

1. An optoelectronic device comprising a substrate providing active circuitry, and an array of smart pixels, each smart pixel comprising part of said active circuitry as well as at least one organic layer which performs at least one of the functions of light detection, light emission, light modulation and light amplification.

2. A device according to claim 1, wherein the substrate comprises a semiconducting layer.

3. A device according to claim 2, wherein the substrate comprises a layer of silicon.

4. A device according to claim 3, wherein said layer of silicon overlies a layer of insulating material.

5. A device according to any preceding claim, wherein the surface of the substrate is smoothed or polished to produce a flat surface.

6. A device according to any preceding claim, wherein the array comprises smart pixels capable of processing information electronically within the pixel.

7. A device according to any preceding claim, wherein the array comprises smart pixels capable of storing information within the pixel.

8. A device according to any preceding claim, comprising electrical means via which smart pixels of the array are arranged to transmit and/or receive information to or from one or more other pixels.

9. A device according to any preceding claim, comprising optical means via which smart pixels of the array are arranged to transmit and/or receive information to one or more other pixels.

10. A device according to claim 8 or 9, wherein said one or more other pixels are in another array.

11. A device according to any preceding claim, wherein the array comprises smart pixels comprising conversion means capable of converting optical signals into electrical signals.

12. A device according to claim 11, wherein said conversion means comprise at least one of a PN junction diode, a PIN diode, a phototransistor and a photoconductor.

13. A device according to claim 11 or 12, wherein said conversion means are in the active circuitry.

14. A device according to claim 11 or 12, wherein the conversion means comprise at least one organic layer formed over the substrate.

15. A device according to any preceding claim, wherein the array comprises smart pixels capable of converting electrical signals into optical signals..

16. A device according to claim 15, wherein said smart pixels capable of converting electrical signals into optical signals are connected to an arrangement of organic light emitting diodes formed in a layer over the substrate.

17. A device according to claim 15, wherein said smart pixels capable of converting electrical signals into optical signals are connected to an arrangement of organic light modulators or amplifiers formed in a layer over the substrate.

18. A device according to any preceding claim, wherein the array comprises smart pixels capable of modifying or amplifying light under the control of electrical signals.

19. A device according to any preceding claim, wherein at least one of the active circuit parts of the smart pixels is arranged to provide a function selected from data buffering, multiplexing, demultiplexing and the handling of data protocols.

20. A device according to any preceding claim, comprising parallel communication links provided by one of spatial, temporal and wavelength multiplexing.

21. A device according to claim 20, wherein different pixels preferentially emit and/or absorb different colours of light so as to provide wavelength multiplexing.

22. A device according to claim 21, comprising microcavity pixel structures providing narrowband sources at selected wavelengths.

23. A device according to claim 22, wherein said structures are doped differently to vary the wavelength from pixel to pixel.

24. A device according to claim 23, comprising narrowband photoluminescent colour conversion pixel structures.

25. A device according to any preceding claim, comprising point-to-point optoelectronic communication links.

26. A device according to any one of claims 1 to 24, comprising multi-cast optoelectronic communication links.

27. A device according to any one of claims 1 to 24, comprising broadcast optoelectronic communication links.

28. A device according to claim 25, 26 or 27, wherein said optoelectronic communication links are reconfigurable.

29. A device according to one of claims 25 to 28, comprising optical waveguide structures integrated with the smart pixels on the same substrate.

30. A device according to any preceding claim, wherein the smart pixels are configured as an intelligent image sensor.

31. A device according to claim 30, wherein the smart pixels are arranged to convert light incident thereon to a digital representation and to store the representation.

32. A device according to any preceding claim, wherein smart pixels are arranged to perform localised image processing operations, such as image enhancement, equalisation or data encryption.

33. A device according to any preceding claim, wherein the smart pixels are configured as an intelligent image display.

34. A device according to any preceding claim, wherein the smart pixels are configured as a printer, optical signals being used to transfer images from storage on the pixel array to a light sensitive film.

35. A device according to any preceding claim, wherein the organic layer comprises a polymer.

36. A device according to any preceding claim, wherein the organic layer comprises a monomer.

37. A device according to any preceding claim, wherein the organic layer comprises a transition metal chelate.

38. A device according to any preceding claim, wherein the smart pixels comprise at least one further layer, selected from an electron transport material layer, a hole transport material layer, a protective cap material layer and a conducting polymer material layer.

39. A device according to any preceding claim, comprising a light permeable electrode in contact with the organic layer.

40. A device according to claim 40, wherein the light permeable electrode is on a side of the organic layer remote from the substrate.

41. A device according to claim 40, wherein the light permeable electrode comprises a conducting polymer.

42. A device according to claim 41, wherein the conducting polymer is a molecularly altered poly(thiophene).

43. A device according to claim 42, wherein the conducting polymer is poly(cthlyendioxythiophene).

44. A device according to claim 43, wherein the poly(ethlyendioxythiophene) is blended with poly (vinyl alcohol).

45. A device according to claim 41, 42, 43 or 44, wherein the light permeable electrode comprises a further layer, selected from indium tin oxide, another light permeable metal or metal oxide, and conducting epoxy resin, on the organic layer of the pixel that is furthest from the substrate.

46. A device according to any preceding claim, comprising at least one organic encapsulation layer on the surface of the device.

47. A device according to any preceding claim, comprising at least one organic encapsulation layer on the surface of the device.

48. A device according to any preceding claim, including an electrode, formed from a higher work function, light permeable, conducting material, selected from aluminium, tungsten, nickel, cobalt, platinum, palladium, niobium, selenium, gold, chromium, tantalum, hafnium, technetium and their alloys, and indium tin oxide, deposited on the substrate.

49. A device according to any one of claims 1 to 47, including a stable metal electrode having a layer of conducting polymer overlying the stable metal.

50. A device according to claim 48 or 49, wherein the electrode is arranged to act as a mirror behind each pixel.

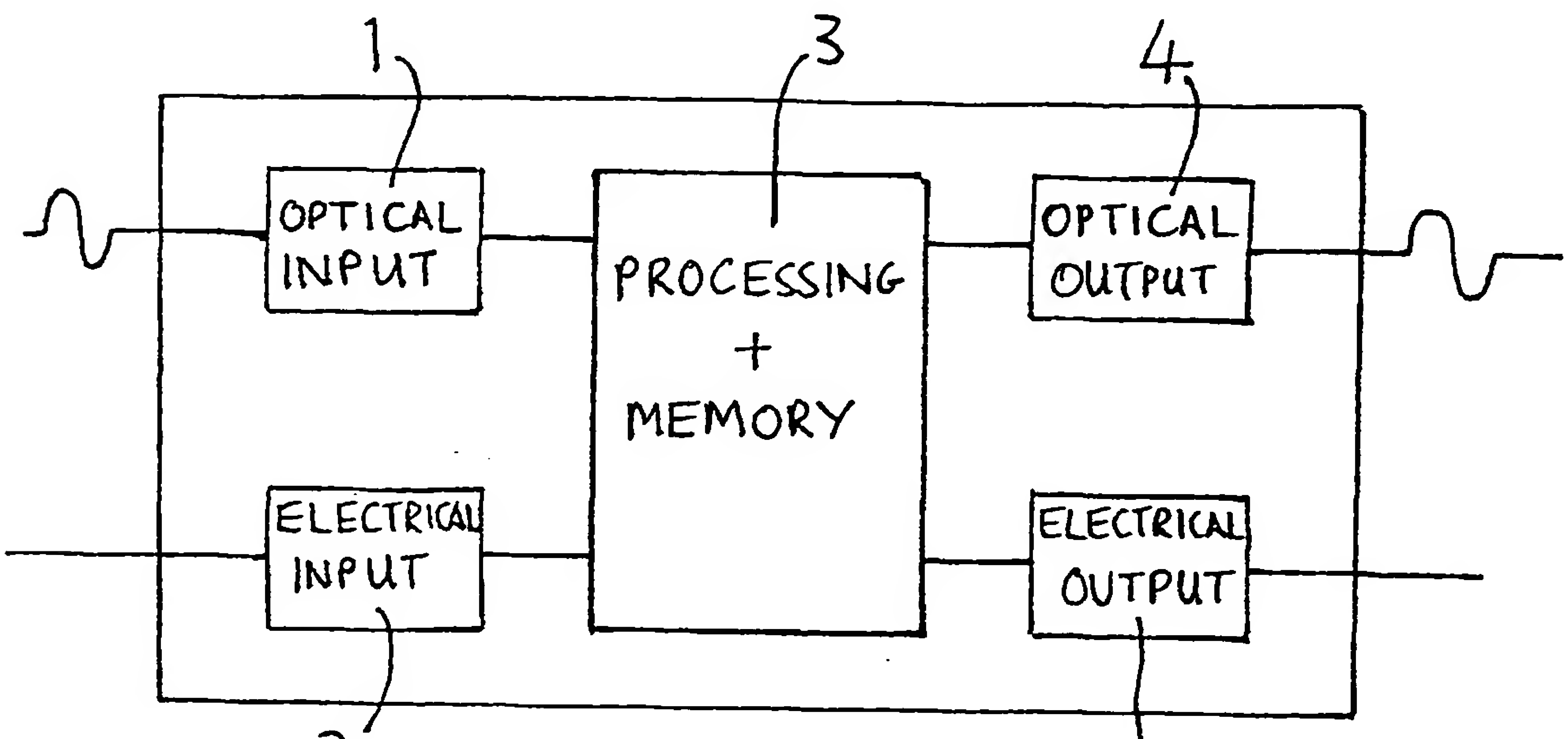
51. A device according to any preceding claim, wherein the substrate comprises circuitry for processing information to address the array of pixels so as to create images.

52. A method of making an optoelectronic device including a substrate comprising semiconducting material and an array of smart pixels arranged on or in the substrate, each smart pixel comprising at least one layer of organic light emitting material, and a light permeable electrode in contact with the organic layer on a side thereof remote from the substrate, wherein the organic layers are integrated directly onto the substrate.

53. A method of making an optoelectronic device including a substrate comprising semiconducting material and an array of smart pixels arranged on or in the substrate, each smart pixel comprising at least one layer of organic light emitting material, and a light permeable electrode in contact with the organic layer on a side thereof remote from the substrate, wherein the organic layers are formed separately and hybridised.

54. A method of making an optoelectronic device including a substrate comprising semiconducting material and an array of smart pixels arranged on or in the substrate, each smart pixel comprising at least one layer of organic light emitting material, and a light permeable electrode in contact with the organic layer on a side thereof remote from the substrate, wherein selective regions of a bottom conducting polymer layer are made non-conducting by exposure to a suitable aqueous solution allowing formation of an array of conducting pixel pads which serve as the bottom contacts of the light permeable pixel electrodes.

55. A method according to claim 52, 53 or 54, wherein a glass or plastics sheet, coated with one of indium tin oxide, conducting polymer, and at least one layer of a light permeable electrode, is bonded to the organic layer of the pixel that is furthest from the substrate or to another layer of this electrode, to serve as a barrier to the ingress of oxygen and water.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OPTICAL INPUT
PROCESSING + MEMORY
OPTICAL OUTPUT
ELECTRICAL INPUT
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Fig. 1

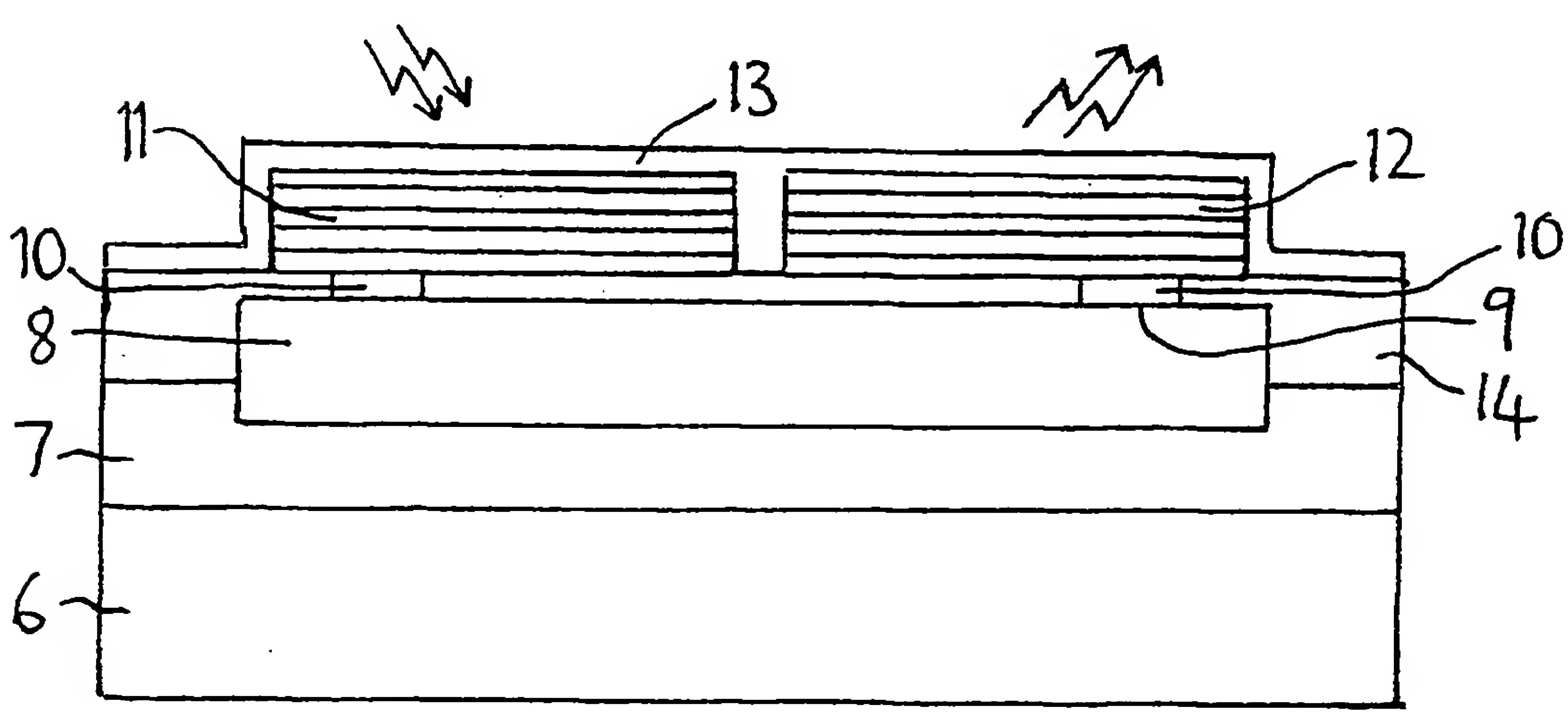
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Fig. 2

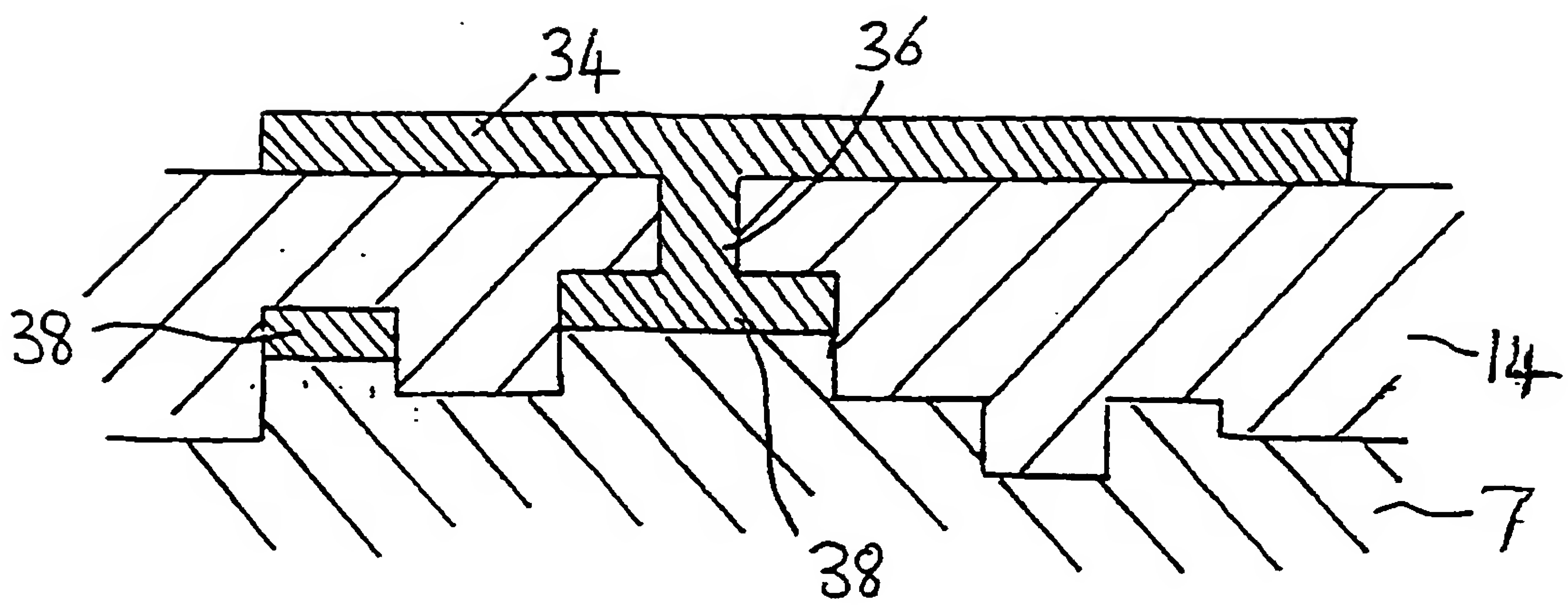

Fig. 3

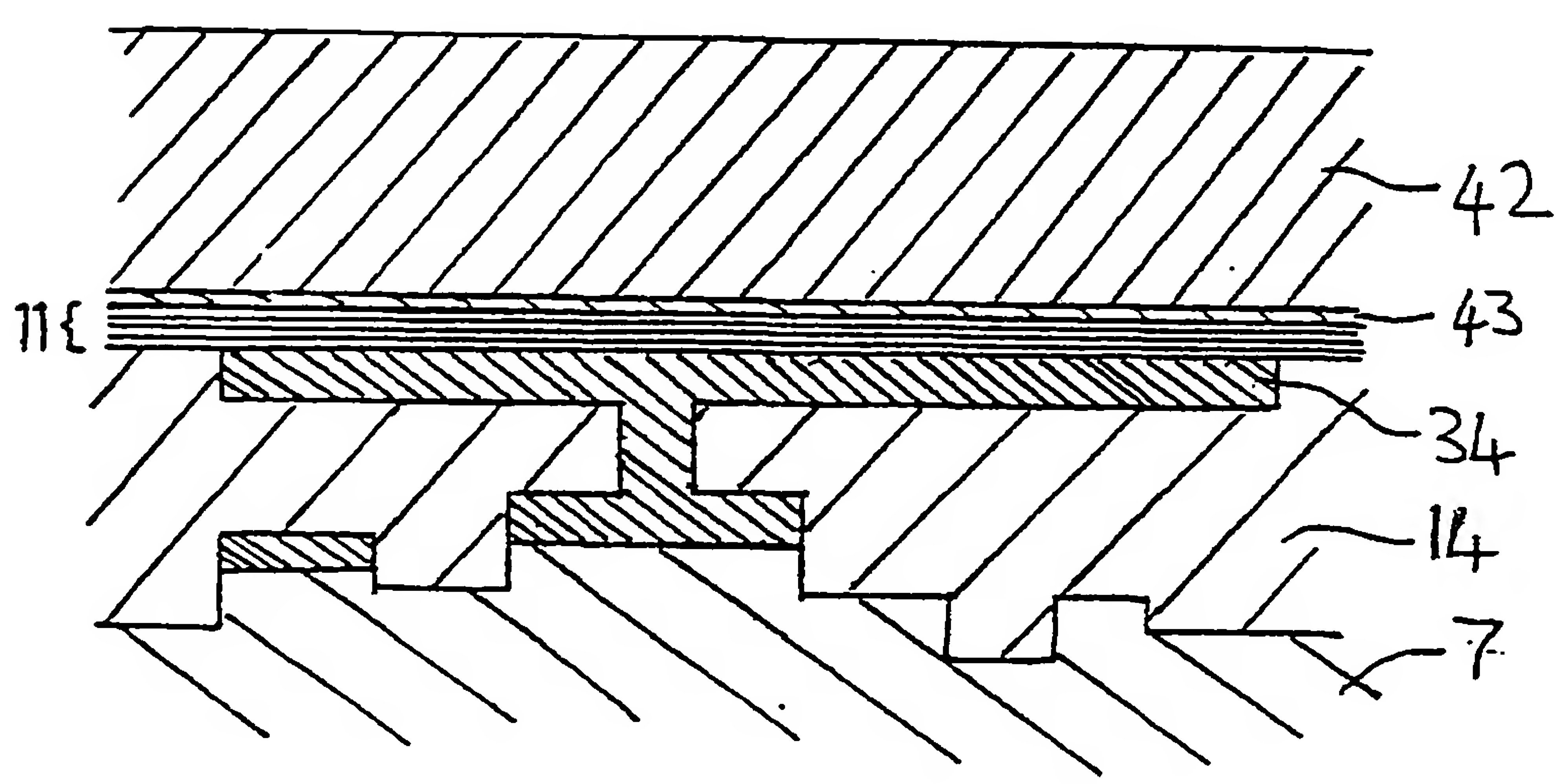

Fig. 4

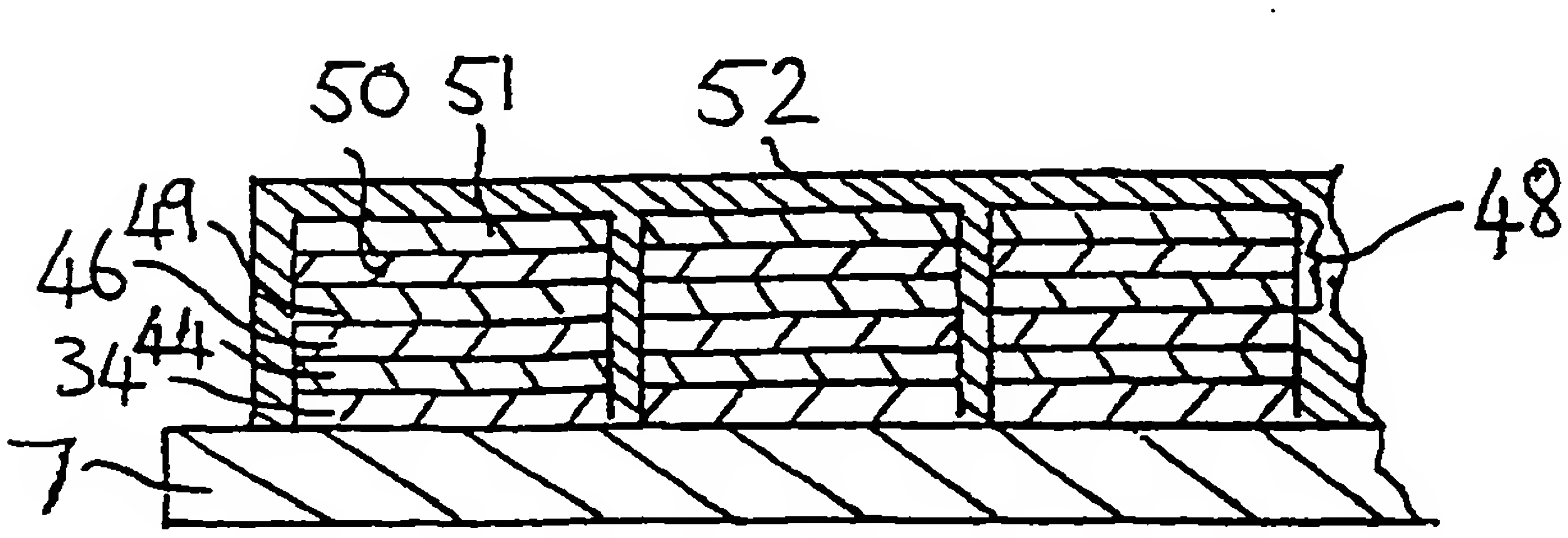

Fig. 5

INTERNATIO''AL SEARCH REPORT

PCT/GB 01/04505

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01L27/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

INSPEC, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WU C ET AL: "DESIGN OF A NOVEL A-SI PIN/OLED IMAGE SENSOR & DISPLAY DEVICE" PROCEEDINGS OF THE SOCIETY FOR INFORMATION DISPLAY, LOS ANGELES, CA, US, 18 May 1999 (1999-05-18), pages 528-531, XP008000255 the whole document ---	1,6,7, 11,12, 15-17, 33,35, 37,39, 40,52,53
A	EP 0 774 787 A (MOTOROLA INC) 21 May 1997 (1997-05-21) cited in the application the whole document ---	1-3,5,6, 15,16, 35-41, 48,51,52
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
20 February 2002	27/02/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	De Laere, A

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	WO 98 21755 A (GRAHAM TERESITA ORDONEZ ;LIEN SHUI CHIH ALAN (US); IBM (US); ANGEL) 22 May 1998 (1998-05-22) page 31, line 13 -page 36, line 12	1-3,15, 16,35, 37-41, 51,52
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